THE EFFECTS OF NON-DIFFERENTIAL REINFORCEMENT AND DIFFERENTIAL REINFORCEMENT ON PROBLEM BEHAVIORS AND ACCURACY OF RESPONDING OF AUTISTIC CHILDREN

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The effects of non-differential reinforcement and differential reinforcement on problem behaviors and accuracy of responding of autistic children was examined. In experiment 1, one child with autism participated, and in experiment 2, two children with autism participated. In the non-differential reinforcement condition both prompted and unprompted responses were reinforced. In the differential reinforcement condition only unprompted responses were reinforced. Overall, problem behaviors were more frequent in the non-differential reinforcement condition. In experiment 1, accuracy was higher in the differential reinforcement condition, while experiment 2 showed inconclusive results with regards to accuracy. It is concluded that non-differential reinforcement can decrease problem behaviors in teaching situations, but may not be sufficient to ensure acquisition of target tasks.

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INTRODUCTION

Autism is a severe disabilty characterized by lack of communication and social skills. Research suggests that an intensive early behavioral intervention is the best treatment currently available for autistic children (Fenske, Zalenski, Krantz, & McClannahan, 1985; Lovaas, 1987). Usually, treatment is as intensive as possible, meaning that many hours of therapy per week are implemented (often 20-40). Ideally, the treatment involves different settings and people as well as many different behaviors (Anderson & Romanczyk, 1999; Lovaas, 1987). This typically means that many teaching trials (demands) are presented to the child with autism.

Discrete trial teaching is an example of a therapist-directed procedure that is commonly used to teach children with autism. In discrete-trial teaching, a therapist presents an instruction or a model, the client responds, and the therapist provides consequences (Anderson, Taras, & Cannon, 1996). Other, perhaps less used, teaching techniques are more "client-led". An example is incidental teaching (Hart & Risley, 1975). In incidental teaching, the environment is arranged to make certain responding more probable. This can include placing objects that the client has approached in the past out of reach, waiting for the client to approach the object, and then using the opportunity to shape a response, with access to the object functioning as a reinforcer (McGee, Morrier, & Daly, 1999; Wolery & Sainato, 1996). Although both techniques have been shown to be effective, problem behaviors may be less likely to occur in client-led than in therapist-led teaching situations. That may in part be because the initiation and

termination of client-led teaching is contingent upon the behavior of the client. If the terminal reinforcer loses its effectiveness, the teaching episode is over. The client can terminate the teaching episode at any time by doing something else. Escape-maintained problem behavior is therefore unlikely to develop. In contrast, discrete trial teaching may easily lead to problem behaviors that may in turn be reinforced by escape (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990) or attention (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993).

Outcomes of some studies suggest that problem behaviors that interfere with teaching are often related to the presentation of demands in client-directed situations. Edelson, Taubman, and Lovaas (1983) found that the frequency of self-injurious and stereotypical behaviors of autistic and mentally retarded children in a state hospital setting was higher following the presentation of demands, denials, and punishments by staff than at other times. Carr, Taylor, & Robinson (1991) found that children who had a history of problem behaviors were more likely than children who did not have such a history to engage in tantrums, aggression, and self-injury when instructed by a teacher. They also found that the problem behaviors had an adverse effect on learning opportunities, since the teachers spent less time teaching the children who engaged in problem behaviors than the others. It seems that the occurrence of problem behaviors in teaching situations may lead to fewer learning opportunities for children who display such behavior. This can in turn lead to appropriate behaviors being reinforced less frequently, and to a lower overall density of reinforcement. As a result, clients may seek

to increase the density of reinforcement by engaging in problem behaviors that have been reinforced in the past through escape and/or attention.

Researchers have explored methods to decrease problem behaviors and increase compliance in teaching situations. Procedures based on behavioral momentum frequently have such an effect. High-probability tasks (that are likely to generate correct responding) are presented before a task that is associated with a lower probability of responding (Nevin, 1996). Mace and colleagues (1988) found that this technique consistently increased compliance with commands that had not previously evoked compliance. Behavioral momentum may have the effect of increasing the number of trials that are reinforced in each teaching session.

Another procedure that can increase the density of reinforcement is non-contingent reinforcement, in which reinforcers are delivered on a time-based schedule rather than being contingent on behavior. Non-contingent reinforcement has been demonstrated to decrease the frequency of problem behaviors (Marcus & Vollmer, 1996). It may be that non-contingent reinforcement leads to increased density of reinforcement that, through satiation, decreases the effectiveness of reinforcers that are maintaining problem behaviors.

Reinforcement density may also be related to increased accuracy of responding Mosk & Bucher (1984) found that a stimulus shaping procedure that led to quicker acquisition and fewer errors compared to a more traditional prompting procedure, also led to a higher density of reinforcement. This raises the question of the extent to which each of these elements was responsible for learning: the features of the stimulus shaping

program, the fact that fewer errors were made, or the increased density of reinforcement. It may be that more than one variable had an effect.

It has been shown that interspersing trials in which previously learned skills are targeted with trials in which unlearned skills are targeted can increase accuracy of responding and lead to faster acquisition (Dunlap, 1984; Dunlap & Koegel, 1980). Interspersal leads to a higher ratio of trials where the children will respond correctly, and it is therefore likely that more responses are reinforced than otherwise would have been. The beneficial effects of task interspersal do not appear to be entirely due to increased density of reinforcement, however. Neef, Iwata, & Page (1980) investigated accuracy of responding and speed of acquisition, but compared a task interspersal condition with a condition where additional reinforcement was provided for task-related behaviors, making the density of reinforcement high in both conditions. Their subjects were mentally retarded children who were learning to spell words. It was found that the task-interspersal method was superior in terms of both acquisition and retention. This suggests that a high density of reinforcement may not be sufficient for optimal learning to take place, but it may still be a necessary component.

The above experiments all have in common procedures that are likely to have the effect of increasing the density of reinforcement. Undoubtedly, the effects for each of these experiments can be at least partly explained in terms of other factors. It seems likely, however, that reinforcement density is a critical variable when it comes to explaining the emergence of problem behaviors. A study by Motiejunas (2000) lends further support to that hypothesis. Motiejunas targeted motor imitation in an 11 year-old-

autistic girl who had a history of self-injury and other disruptive behaviors following the presentation of demands. An alternating treatment design was used where, in one condition, all responses, both prompted and unprompted, were reinforced with edibles and praise (non-differential reinforcement) but, in the other condition, only correct (unprompted) responses were reinforced (differential reinforcement). It was found that a higher frequency of problem behaviors was associated with the reinforce-corrects-only condition than the reinforce-all condition. Verbalizations were also more frequent during the reinforce-all condition, and accuracy was as high or higher.

The current experiment was conducted in order to replicate and expand upon Motiejunas' (2000) experiment. The general purpose was to investigate whether a non-differential reinforcement procedure in which all responses, prompted and unprompted, were reinforced, would produce fewer problem behaviors than a differential reinforcement procedure in which only correct unprompted responses were reinforced. The effects of those two procedures on accuracy of responding were also examined.

EXPERIMENT 1

Method

Participant

The participant was a 5-year-old boy with a diagnosis of pervasive developmental disorder, not otherwise specified. At the time of the study he received several hours per week of in-home behavior therapy. The participant was chosen based upon parental report that stated that he had a history of problem behaviors such as running away and throwing things, which would often occur upon the presentation of demands.

Setting

All sessions were conducted in the subject's home. Two rooms were used during the course of the experiment. During the first half of the experiment, a playroom containing only a table, two chairs and some toys was used. In the second half of the experiment, when access to a videogame was added as a reinforcer, sessions were conducted in the living room. The same table and two chairs were still present. The living room also contained a couch and two more tables.

Materials

Legos and wood blocks were used as materials for the imitative task, and the "Duplo" variety of Lego was used. Four blocks were used in each task. The wood blocks

were approximately the same size as the Legos. Pencil and paper were used to record the target behaviors. Small pieces of fruit-roll-ups and access to a videogame were used as reinforcers. Both of these were known to be effective reinforcers for this participant's behavior.

Measurement

Accuracy was calculated as the number of unprompted responses in a five-trial session (in baseline, each session was three trials). Unprompted responses were defined as the completion by the subject of four-piece structures consisting of wooden blocks and Legos, as modeled by the experimenter, without any additional prompting. The nature of the task was held constant throughout the experiment.

A trial was counted as containing problem behaviors if any of the following behaviors occurred: Block-throwing was counted if the subject made direct contact with the legos/blocks with the result of them ending up anywhere else than on the table. If the subject shook the table so that the materials fell down, that was also considered block-throwing. Chair-throwing was counted if the subject made direct contact with a chair, causing it to fall down. Throwing table was counted if the subject pushed, kicked or otherwise manipulated the table so that it toppled over. If the therapist intervened to prevent the table from toppling over, the response was still counted. If the subject shook the table without it toppling over, it was not counted as table-throwing. It might be counted as a block-throw, however (see above). Prompt resistance was counted if the subject physically resisted manual prompts and the resistance was of a sufficient force to slow the prompting down. Escape was counted if the subject left the chair at any time

within a block of trials. An exception was if he stood within a foot of the table and oriented towards it. That response was not considered escape, even if the participant was not sitting. If, on the other hand, the subject lay or sat on the floor, an instance of escape was counted.

Interobserver reliability

Interobserver reliability was not obtained for experiment 1. Only 2-3 sessions were videotaped and a second observer was not present when the experimenter gathered the data.

Procedures

In each session, a trial began when the experimenter said, “do this” while modeling the correct response, and ended when the next trial began. An exception was the first trial in each session, which began when the subject was seated at the table with the materials in front of him, and ended when the therapist said “do this”, signaling the beginning of second trial of the session. The last trial in the block ended when the therapist told the subject that he could go. Each response was recorded only once within a trial.

Baseline: The target tasks were the construction of four-piece block structures, one made out of Lego blocks and the other out of wood blocks, as modeled by the experimenter. In baseline, the experimenter modeled each task and then said: “Do this”. Correct responses were to be followed by praise, but no such responses occurred. No programmed consequences followed incorrect responding. No prompting was provided in baseline. The experimenter simply recorded whether the participant made a correct

response and whether problem behaviors occurred. After 20 seconds, the experimenter proceeded to the next trial. If the participant was still attempting to complete the target task after 20 seconds, the experimenter waited until he stopped, and then went on to the next trial. Three trials were run in each session in baseline. One session of each task was run each day, so that a total of six trials were run per day over three days.

Intervention: Two conditions were conducted in intervention. In the non-differential reinforcement condition, all responses were reinforced, prompted and unprompted. In the differential reinforcement condition, only unprompted responses were reinforced. In both conditions, hand-over-hand prompting was provided as necessary to ensure that the subject finished the construction of each structure in every trial. Prompting was provided within a few seconds after the participant had made an error. An error was defined as any response other than the target response. This included putting a block in the wrong place, or not responding at all. If a block was put in the wrong place, the experimenter waited for approximately three seconds, giving the participant a chance to correct the error. If the participant either stopped responding for more than three seconds, or continued building without correcting the prior error, the experimenter used hand over hand prompting to complete target task. In the differential reinforcement condition, the experimenter presented the next trial immediately after the completion of a prompted response. In the non-differential reinforcement condition, the experimenter delivered reinforcers after each response (prompted or unprompted), waited while the participant consumed the reinforcers, and then proceeded with the next trial. When access to a videogame was used as a reinforcer, the experimenter allowed the participant to play

for approximately 30 seconds before beginning the next trial. In intervention, each session consisted of five trials. One session in each of two conditions was conducted each day of the experiment, so a total of 10 trials were conducted each day.

Experimental design

An alternating treatment design was used. In baseline, both target tasks were presented under a differential reinforcement contingency. In intervention, the block task was at first presented in the non-differential reinforcement condition, and the Lego task in the differential reinforcement condition. The tasks were later reversed between conditions.

Results

Problem behaviors

Figure 1 shows the cumulative occurrences of problem behaviors in experiment 1. In baseline (trials 1-18), problem behaviors occurred in nearly every trial. As soon as the non-differential condition was put in effect for the Lego task, the problem behaviors decreased for that task. Problem behaviors continued to occur during the wood block task. In the last 5-6 sessions of the first intervention phase (trials 67-127), the problem behaviors can be seen to steadily decrease in both conditions. In the last two sessions before reversal (trials 107-127), no problem behaviors were occurring at all.

In trials 58-67 the number of trials with problem behaviors was four in the non-differential condition, and zero in the differential reinforcement condition. This finding is in sharp contrast with the rest of the data, and cannot be adequately explained with the information currently available.

After trial 127, a reversal condition was put in effect. After the reversal, the Lego task was presented in the differential reinforcement condition, and the wood block task was presented in the non-differential reinforcement condition. It is important to note that the participant only came into contact with those new contingencies in the Lego condition, where every response had been reinforced before, but now only correct, unprompted responses were reinforced. Since no errors were occurring in the block condition in the last three sessions before reversal, every response was already being reinforced. The programmed change in contingencies therefore did not make a difference procedurally in the block condition. As can be seen in figure 1, only two instances of trials with problem behaviors were recorded in the reversal condition. These occurred in the differential reinforcement condition, in which the Lego task was now presented. In the last four sessions, which were composed of trials 147-197, no problem behaviors occurred.

Figure 2 shows problem behaviors in a session-by-session manner. The data were rather unstable in the intervention phase but, more often than not, problem behaviors occurred during more trials in the differential reinforcement condition than the non-differential reinforcement condition. Figure 3 shows the total number of trials with problem behaviors across phases and conditions. Although there was little difference in the total number of problem behaviors in baseline, more than twice as many trials with problem behaviors occurred in intervention in the differential reinforcement condition than in the non-differential reinforcement condition.

Accuracy

Figure 4 shows the accuracy of responding, displayed cumulatively. In baseline trials 1-18, in which the differential reinforcement contingency was in effect for both tasks, no correct responses occurred. In the first phase of intervention (trials 19-127), the Lego task was presented in the non-differential reinforcement condition, whereas the wood block task continued to be presented in the differential reinforcement condition. The accuracy of responding was higher in the differential reinforcement condition, with only three instances of overlap.

In trials 97-127, accuracy was stable at 100% in the differential reinforcement/blocks condition, but ranged from 0% - 60% in the non-differential reinforcement/Lego condition. A reversal occurred at that point, so that the Lego task was now presented in the differential reinforcement condition, and the wood block task was presented in the non-differential reinforcement condition. After the reversal, accuracy in the block task continued to be 100%. During trials 133-142, accuracy in the Lego task decreased below the level at which it had been before the reversal, but reached levels of 80-100% in trials 173-197.

Figure 5 shows accurate responses in a session-by-session manner. As can be seen, accuracy was more often than not higher in the differential reinforcement condition than in the non-differential reinforcement condition during intervention. Towards the end of the experiment the participant could perform both target tasks with 100% accuracy.

Figure 6 shows the total number of accurate responses across phases and conditions of the experiment. As can be seen, more accurate responses occurred for the wood block task in both the intervention and the reversal phase.

Discussion

In experiment 1, more problem behaviors occurred when a task was presented under a differential reinforcement contingency than when a task was presented under a non-differential reinforcement contingency. The results replicate those of Motiejunas (2000), where problem behaviors were also more likely to occur in the differential reinforcement condition than in the non-differential reinforcement condition. A possible explanation for the difference between the two conditions is that if much prompting is needed in the initial stages of a teaching program, the schedule of reinforcement is leaner in the differential reinforcement condition than in the non-differential reinforcement condition. During the differential reinforcement condition, the learner may as a result engage in alternative behaviors that have been reinforced in the past. Those are likely to include behaviors that interfere with learning or are considered problematic in some other way. The opposite may apply in the non-differential reinforcement condition. If task-related behaviors such as approximations to a correct response or compliance with a prompt are indeed being reinforced, other behaviors (including problem behaviors) might be less likely to occur.

Whereas the current results are consistent with those of Motiejunas (2000) with regards to problem behaviors, the same cannot be said for accuracy of responding. In Motiejunas's experiment, the subject responded more accurately in the non-differential

than in the differential reinforcement condition. In the present experiment, more correct responses occurred in the differential reinforcement condition than in the non-differential reinforcement condition and 100% accurate responding was established earlier.

Why was accuracy of responding lower in the non-differential than in the differential reinforcement condition? The non-differential contingency may initially be successful in decreasing the frequency of problem behaviors, but may not be sufficient to ensure task acquisition. Since reinforcers were always presented contingent upon the completion of a hand-over-hand prompt, compliance with the prompt may have been reinforced. The high density of reinforcement in the non-differential reinforcement condition may also (by way of satiation) have made the any single instance of reinforcement less potent. Conversely, deprivation resulting from a low density of reinforcement in the differential reinforcement condition may have resulted in each instance of reinforcement becoming more potent. Hence, task related behaviors would be more likely to be strengthened in the differential than in the non-differential reinforcement condition. It is also possible that the consumption of the reinforcers was in part incompatible with the occurrence of problems behaviors. However, because there were ample opportunities for problem behaviors to occur, both during task presentation and hand-over-hand prompting, that was probably not a major factor.

Since there was no systematic differential reinforcement for correct unprompted responses in the non-differential reinforcement condition, it is perhaps not surprising that acquisition occurred slowly in that condition. There was, however, a differentiating factor, which made a correct and a prompted response discriminable for the subject. That

factor was the presence of a hand-over-hand prompt. For that variable to be effective, the hand-over-hand prompt would have to be aversive, so that variables correlated with its absence would serve as reinforcers for emitting unprompted correct responses. It may have been the case that the hand-over-hand prompt was not an aversive stimulus for this participant in this experiment. The fact that prompted responses were reinforced in the non-differential reinforcement condition may have decreased the probability of the hand-over hand prompt acquiring aversive properties. This may account for the limited acquisition that took place in the non-differential condition.

The differing nature of the tasks may also have contributed to the differences in accuracy between Motiejunas' (2000) experiment and the present experiment. In Motiejunas' experiment, the same types of tasks (gross motor imitations) occurred in both conditions throughout the experiment. In the present experiment, that was not the case. The Legos and wood blocks were presented in separate conditions in the first intervention phase as well as in the reversal phase. Therefore, physical properties of the tasks might have been a confounding variable. It might be argued that the Lego task required more precision, since the Lego blocks had to be put together in a certain way for them to fit together. The wood block task allows for more latitude, since the blocks only need be put on top of one another, and do not have to be fit together with as much precision as was the case with the Legos. It might therefore be argued that the wood block task was easier, and therefore more correct responses occurred when that task was presented. This hypothesized difference in difficulty did not have an effect in baseline, but a longer baseline might have revealed a difference. Additionally, the participant may

have had more prerequisites for the wood block task than for the Lego task in his repertoire. As a result, prompting may have lead to faster acquisition of the wood block task than the Lego task.

If the wood block task was indeed easier than the Lego task, one might intuitively assume that problem behaviors would be more likely to occur contingent upon the presentation of the latter task. That did not happen, perhaps because the non-differential reinforcement contingency decreased the probability of such behaviors.

EXPERIMENT 2

Introduction

In experiment 2, an attempt was made to hold the nature and difficulty of the target tasks constant across the differential and non-differential reinforcement conditions, and another participant was added.

Method

Participants

Participants were two boys who were receiving in-home behavioral treatment at the time of the experiment. Participant 1 is the same subject that participated in experiment 1. He was, at the time of experiment 2, a year older than he was at the time of experiment 1. Participant 2 had a diagnosis of autism and was four years old at the time of the study. He had a history of avoiding demands by looking away and not responding to instructions.

Setting and schedule

The experimental sessions took place in the subjects' homes at the times of their regularly scheduled behavior therapy hours. The sessions for participant 1 took place 2-3 days a week, in the afternoon between the hours of 12.30 to 3:30. The setting was the same as in the second half of experiment 1. Two sessions, one in each condition, were usually conducted each day (always with at least 2 hours in between), but due to varying time constraints, only one session was conducted on some days. The sessions for participant 2 took place 2-3 days a week between 10-12 AM. Every session was

conducted in his bedroom. On each day of the experiment, two sessions were conducted, one in each condition. At least one hour passed between the sessions that were conducted in a single day.

Materials

For participant 1, red and blue Lego blocks were used for the target task. For participant 2, small puppets depicting the characters Winnie the Pooh and Barney the Dinosaur were used in the target task. The experimenter used pencil and paper to take data, and a portable video camera was used to tape each session. For participant 1, pieces of fruit-rollup were used as reinforcers, as well as access to either a videogame or a movie. For participant 2, goldfish crackers and access to a movie were used as reinforcers.

Measurement for participant 1

An accurate response was counted if the participant put together a specific configuration consisting of seven Lego blocks, as modeled by the experimenter in each trial, without additional prompts. The nature of the task was held constant across conditions throughout the experiment.

The definitions of the problem behaviors were as follows: Block throwing was counted if the subject made direct contact with the blocks with the result of their ending up anywhere else than on the table. If the subject shook the table so that the materials fell off the table, that was also counted as throwing blocks. Other throwing was counted if the subject made contact with other objects that resulted in their falling to the floor (e.g. the chair, the table, the pencil, etc). Prompt resistance was counted if the subject physically

resisted manual prompts and the resistance was of a sufficient force to slow the prompting down. Escape was defined as the subject exiting the chair at any time during the session. If he was standing within a foot of the table and oriented towards it, that was not considered escape. If the subject lay or sat down on the floor, that was also considered escape, regardless of the distance from the table. Pinching, hitting, kicking, headbutting or otherwise assaulting the experimenter or any other person was counted as an aggressive response.

Measurement for participant 2

An accurate response was defined as a correct response to a question about the Winnie the Pooh and Barney the Dinosaur puppets. The experimenter held up one of the puppets and ask either one of two questions: “Is this Pooh”, or “Is this Barney”. The correct answer would be either yes or no depending upon which question was being asked and which puppet was being held up. A correct response was scored only if the subject answered clearly, without saying another understandable word before the yes/no response.

The problem behaviors that were measured were: Looking away, which was scored if the participant looked at something other than either the experimenter or the materials for five seconds, beginning when the experimenter raised either one of the puppets. An instance of inappropriate vocalizations was scored if the subject cried or screamed during a trial.

Interobserver agreement

Interobserver agreement data were obtained for 50% of sessions for each participant. It was calculated by counting the number of trials in each session in which two observers agreed about the occurrence and nonoccurrence of behavior. That number was then divided by the total number of trials in the session and multiplied by 100. For participant 1, average agreement on problem behaviors other than block throwing was 97%, with individual sessions ranging from 80%-100%. Average agreement for accuracy was 100%. Separate agreement was calculated for block throwing of participant 1. The agreement with regards to that behavior was 99%, with a range of 80%-100%. For participant 2, total agreement on problem behaviors was 98%, with individual sessions ranging from 80%-100%. Total agreement on the accuracy of responding for participant 2 was 98%, with a range of 88%-100%. In two instances, the videotape ran out before the session was completed. In those cases, the trials that were caught on tape were scored (hence the 88%).

Data analysis

For problem behaviors, the unit of analysis was the occurrence or nonoccurrence of any of the defined problem behaviors during each trial, as well as across sessions. The exception was block-throwing by participant 1, which was analyzed separately from the other problem behaviors. For accuracy, the unit of analysis was the occurrence or nonoccurrence of an unprompted, correct response in each trial, as well as the number of such responses across sessions. Finally, the total occurrences of both problem behaviors and accurate responses in each experimental condition were summed and compared.

Experimental conditions

Two conditions were common to both subjects. In the non-differential reinforcement condition, both prompted and unprompted responses were followed by praise and reinforced with tangibles and access to preferred activities. In the differential reinforcement condition, only unprompted responses were praised and reinforced with tangibles.

Two other conditions were put in place for participant 1 in the second half of the experiment. In the “throws blocked” condition, the experimenter stopped the subject from throwing the lego blocks and physically prompted him through the target response. In the “pick-up-blocks” condition, the experimenter prompted the subject to pick up any lego blocks the subject had thrown on the floor, and then prompted the subject through the target response.

Procedures for participant 1

In baseline, sessions took place with the subject and the experimenter seated side by side at a table. On each occasion, the experimenter had previously put on the table the appropriate amount of blocks needed to complete the target task. Each trial began when the experimenter said: “Do this” and began to model a block-building response, using either red or blue Legos. A differential reinforcement contingency was in effect for both red and blue Legos during baseline. Correct responses were to be followed by both praise and tangible reinforcement. Only one such response occurred in baseline. Incorrect responses were followed by a hand-over-hand prompt, but no other programmed consequences followed. Prompting was provided within few seconds after the participant

made an error. The experimenter gave the participant a chance to correct the error, but if the participant either stopped responding for more than three seconds, or continued building without correcting the prior error, the experimenter prompted the rest of the target task hand over hand. When problem behaviors occurred, the experimenter did not respond in any specific way, but simply continued presenting trials and prompting as planned. Each session in baseline ended with the experimenter saying: “You can go and play”.

In intervention, the procedures were identical to baseline, except that the red and blue blocks were presented under differing conditions. Other than the color of the blocks, the nature of the task was held constant across conditions throughout the experiment. The blue blocks were presented in the differential reinforcement condition, and the red blocks were presented in the non-differential reinforcement condition. In the non-differential reinforcement condition, every trial concluded with the presentation of a reinforcer. After the participant consumed the reinforcer, the next trial was presented. In the differential reinforcement condition, only correct unprompted responses were reinforced; if prompting was needed, the experimenter initiated the next trial after the completion of the prompt.

When problem behaviors such as block-throwing and table-throwing occurred, both in baseline and intervention, the experimenter did not respond in any specific way to those behaviors. However, it was necessary for the experimenter to leave the table and pick up the items that had been thrown. Late in the experiment, conditions were changed so that the experimenter attempted to stop the participant from throwing blocks upon the

first signal that he was going to do so. After that the procedures were again changed so that the experimenter allowed the participant to throw the blocks, physically prompted him to go and pick up all that he had thrown, and then physically prompted the participant through the target task.

Procedures for participant 2

In baseline, both types of puppets and both questions were presented under a differential reinforcement contingency. The experimenter and participant sat face to face in two chairs. A trial began when the experimenter held up either one of the puppets in front of the participant. The experimenter waited for the participant either to make eye contact or to look at the puppet that was being held up. When that occurred, the experimenter immediately asked one of two questions ("Is this Pooh", or "Is this Barney"). If eye contact did not occur within 5 seconds, the experimenter scored an instance of "looking away". After that, the experimenter held up the puppet again and asked the question immediately without waiting for eye contact. After the question was asked, the experimenter waited five seconds. If the correct response was emitted within that time, reinforcement was provided. If five seconds passed without a correct response, the experimenter prompted the correct response by modeling the correct word and then initiated the next trial. There were no programmed consequences for inappropriate vocalizations.

During intervention, procedures were identical to baseline, except that the Barney puppet was presented in the differential reinforcement condition, and the Pooh doll was presented in the non-differential reinforcement condition. In the latter condition, every

trial ended with reinforcement, regardless of whether or not a correct response was emitted. The experimenter waited while the participant consumed the reinforcer and then presented the next trial.

Experimental design

An alternating treatment design was run for each participant, in which non-differential and differential reinforcement contingencies were compared. In addition, a differential reinforcement baseline was run for each subject.

Results

Figure 7 shows cumulative occurrences of block throwing for participant 1. Block throwing was analyzed separately from the other problem behaviors, because the behavior proved to be insensitive to the differing densities of reinforcement that were the main focus of the experiment. As can be seen, block throwing only occurred three times during the first 20 trials. During those trials, the task consisted of assembling a specific configuration of five Lego blocks. After 20 trials, two blocks were added to the task so that it now consisted of seven blocks. In trials 25-40, block throwing occurred more frequently, and in trials 41-60, it was seen in every trial.

Intervention was implemented after the 60th trial. Thereafter, red blocks were presented in the non-differential reinforcement condition and blue blocks in the differential reinforcement condition. In trials 21-100, block throwing continued to occur in every trial, across both conditions. In trials 101-110, the experimenter attempted to stop the participant from throwing the blocks. That procedure proved cumbersome and difficult to implement but, nevertheless, block throwing decreased slightly. In trials 110-

140 the experimenter prompted the participant to pick up all blocks that he threw. That intervention was eventually effective in decreasing the frequency of block throwing to two during the last 10 trials.

Figure 8 is a trial-by-trial cumulative graph showing occurrences of problem behaviors other than block throwing. In baseline (trials 1-60) problem behaviors occurred somewhat inconsistently, ranging from zero to four in each block of five trials. No clear pattern was seen during baseline. After the intervention was put in place, effects were immediately seen. In trials 61-110, problem behaviors continued to occur in the differential reinforcement condition, but decreased in the non-differential reinforcement condition. In trials 111-140, the occurrence of problem behaviors was equally low in both conditions.

The sessions-by-session frequencies of problem behaviors other than block throwing are shown in figure 9. At the beginning of baseline, problem behaviors were more frequent when the red Legos were presented, but towards the end of the baseline, they were more frequent when the blue blocks were presented. The number of problem behaviors was consistently higher in the differential reinforcement condition until the pick-up-blocks contingency was put into effect. After that, problem behaviors occurred infrequently.

Overall number of problem behaviors other than block throwing is seen in figure 10. In baseline, when both red and blue blocks were presented in the differential reinforcement condition, there was little difference between the two conditions. In intervention, problem behaviors occurred during 19 trials during the differential

reinforcement condition, in which the blue blocks were presented, but only during 5 trials in the non-differential reinforcement condition, in which the red blocks were presented.

Figure 10 is a session-by-session graph of the accuracy of responding of participant 1. There were only two instances of an accurate response during the experiment. The first one occurred during baseline, and the second one occurred near the end of the experiment. Both of the accurate responses occurred when the blue blocks were presented.

Figure 12 shows the cumulative trial-by-trial occurrences of problem behaviors for participant 2. The differential reinforcement condition was in effect in baseline, and both types of toys (Barney the dinosaur and Winnie the Pooh) were presented in that condition. Problem behaviors occurred in most trials, with the exception of trials 41-50, where problem behaviors occurred in six trials out of ten. In the first intervention phase (trials 61-220), Winnie the Pooh was presented in the non-differential reinforcement condition, while Barney continued to be presented in the differential reinforcement condition. The problem behaviors immediately decreased in frequency at the start of intervention. The decrease was more prominent in the non-differential than in the differential reinforcement condition. During trials 91-130, problem behaviors fell to zero, but during trials 130-220, they reappeared, mainly in the differential reinforcement condition.

Starting with trial 221, a reversal phase was put in effect. Barney was now presented in the non-differential reinforcement condition, and Winnie the Pooh was presented in the differential reinforcement condition. Problem behaviors continued to

occur more often in the differential reinforcement condition than in the non-differential reinforcement condition.

Figure 13 shows the problem behaviors of participant 2 in a session-by-session manner. The implementation of the non-differential reinforcement condition (session 4) immediately resulted in a decrease in the frequency of problem behaviors. Problem behaviors occurred more often in sessions in which the differential reinforcement condition was in effect. Problem behaviors continued to occur more often in the differential reinforcement condition after the contingencies were reversed for Pooh and Barney.

Figure 14 shows the total number of trials in which problem behaviors occurred for each phase and condition of the experiment. There was little difference in the number of problem behaviors between the two stimulus presentations in baseline. However, during the first intervention phase as well as the reversal phase, many more problem behaviors occurred in the non-differential reinforcement condition.

Figure 15 shows the cumulative occurrences of correct responses by session for participant 2. During baseline (trials 1-60), no correct responses occurred. Since a differential reinforcement condition was in effect in baseline, and no correct unprompted responses occurred, no reinforcers were delivered during the baseline. The first correct response occurred in the second trial of the first non-differential reinforcement session (trials 61-70), immediately after the first reinforcer of the experiment had been delivered. For the remainder of the experiment, the number of correct responses oscillated but never reached 100% in any given session. During trials 60-100, the participant tended to say

"yes" to any question, and therefore got close to 50% correct in each session. In trials 110-280, the participant would often say "no" to a question, and the number of correct responses continued to be close to or just below 50% for each session (with a few exceptions, such as trials 171-180).

Figure 16 shows a session-by-session analysis of the differences in accuracy between the experimental conditions during intervention. During sessions 4-9, accuracy was slightly higher in the non-differential reinforcement condition than in the differential reinforcement condition (with the exception of session 5). The difference disappeared during sessions 10-11, and there were no systematic differences in accuracy in the reversal phase.

Figure 17 shows the number of accurate responses by condition and phase. Ten more correct responses occurred in the non-differential reinforcement condition than in the differential reinforcement condition during the first intervention phase. The overall number of correct responses was almost equal across conditions in the reversal phase, however.

Discussion

For both participants, problem behaviors were less likely to occur in the non-differential than in the differential reinforcement condition. Although the non-differential reinforcement contingency did not eliminate the problem behaviors, significant reductions from baseline levels occurred for both participants. The reversal phase for participant 2 further revealed that the occurrence of problem behaviors was related to the experimental conditions rather than the nature of the task.

Block-throwing by participant 1 turned out not to be sensitive to the differing contingencies of reinforcement. The behavior decreased, however, when the participant was prompted to pick up the blocks. It seems likely that being prompted to pick up the blocks functioned as punishment for throwing the blocks. Additional sessions might have established that more clearly, but time constraints made that impossible.

Participant 1 made only two accurate responses throughout the second experiment. Anecdotally, he either did not attempt to put the Legos together at all, or he made a mistake on the second or third block. Participant 2 responded more accurately in the non-differential than in the differential reinforcement condition. These results were different from those seen in experiment 1, where participant 1 responded more accurately in the differential reinforcement condition. Even though the difference was not great, it was consistent throughout most of the first intervention phase, but disappeared in the last few sessions. The difficulty of the tasks cannot be said to have been a factor in experiment 2, as was likely the case in experiment 1. Whereas the responses required in the completion the target tasks differed across conditions in experiment 1, they were the same in experiment 2 for participant 2 (saying yes or no). It is therefore possible that the non-differential reinforcement condition had the effect of increasing the occurrence of correct responses, at least temporarily.

Little can be said about the relationship of the experimental conditions to accuracy of responding based on the current results. It can be concluded that the task difficulty was set too high above the current behavioral control and that simple prompting and reinforcement (either differential or non-differential) were insufficient to accomplish

the target responses. This situation is not unlike that often found in the teaching of children with developmental disabilities. The current results suggest that when a student is having little success, many errors are being made and a lot of prompting is needed, non-differential reinforcement can minimize the occurrence of problem behaviors.

Interestingly, the accuracy for participant 2 was zero in baseline. The first correct response occurred in the second trial of the first non-differential reinforcement phase; just after the first reinforcer of the experiment had been delivered. As soon as a prompted response was reinforced, accurate responses started to occur. While this could have been due to prior learning that may have taken place during baseline, another possibility is that the reinforcement increased the probability of responding in the absence of a prompt. It may be the case that an early delivery of a reinforcer in a session increases the likelihood of success within that session.

GENERAL DISCUSSION

The results of both experiments support the general hypothesis that a schedule of non-differential reinforcement, in which prompted as well as unprompted correct responses are reinforced, may serve to keep the frequency of problem behaviors at low levels in discrete-trial teaching situations. Differential reinforcement, in which only correct unprompted responses are reinforced, may be associated with greater frequency of problem behaviors, especially in early stages of learning. As demonstrated by Edelson et al. (1983) problem behaviors sometimes follow direct demands from an adult to a child. Thus, it is possible that the presentation of demands under differential reinforcement contingencies may result in correlated stimuli becoming aversive due to low probability of reinforcement. If problem behaviors following demands had been reinforced in the past, the demands may then evoke problem behaviors (Iwata et al., 1990; Vollmer et al. 1993). The problem behaviors may be likely to decrease with time through extinction, except when they are maintained by unsuspected variables such as reactions of the experimenter, as the case seemed to be with the block-throwing of participant 1 in experiment 2. On the other hand, it is certainly the case that the non-differential reinforcement procedure results in greater association of demands with reinforcement. High density of reinforcement at the beginning of intervention may prevent problem behaviors from occurring at a high rate and additional reductive strategies may not be needed.

Non-differential reinforcement is not the only procedure that produces such a result. Noncontingent reinforcement, in which reinforcers are delivered on a time-based schedule, has also been shown to decrease the frequency of problem behavior (Marcus & Vollmer, 1996; Vollmer et al., 1993). Those two procedures, along with procedures based on behavioral momentum (Mace et al., 1988) and task interspersal (Dunlap, 1984), may all have the effect of increasing the density of reinforcement in teaching situations. Increased density of reinforcement may have the general effect of decreasing the probability of the occurrence of problem behaviors.

Although non-differential reinforcement may increase the opportunities for teaching (Carr et al., 1991), it is unclear whether it leads to increased learning. Motiejunas (2000) found that to be the case, while the current experiment produced mixed results. In experiment 1, differential reinforcement may have been a necessary condition for acquisition to take place. Both types of tasks reached 100% accuracy while they were being presented in the differential reinforcement condition. In experiment 2, participant 2 was more likely to respond accurately in the non-differential reinforcement condition during the first intervention phase. That difference disappeared in the reversal phase. Many variables may affect what kind of reinforcement contingency is necessary for a task to be mastered. It may be that in some cases non-differential reinforcement increases the variability of behavior. Differential reinforcement may then be necessary to select the desired response topographies. On the other hand, if a person can already emit most or all of the behaviors that are necessary prerequisites for the target response, increased reinforcement density may be all that is needed. Non-differential reinforcement

may then be enough to generate 100% accuracy. This may have been the case in Motiejunas' (2000) experiment, whereas in the current experiments, the participants may not have had the prerequisites needed for the target responses to occur without a more extensive teaching program.

A general strategy for discrete trial teaching can be proposed based on the above considerations. In the initial stages of a teaching program, the task should be presented under a non-differential reinforcement schedule or another procedure that leads to a high density of reinforcement. This decreases the probability of problem behaviors occurring, and reinforces compliance with the prompt. As the prompt is faded, a differential reinforcement schedule may be put in place. At that stage, the occasional non-reinforced response may be less likely to produce problem behaviors because a history of positive reinforcement in the presence of the task has been established in the initial sessions. If the fading program is successful, the student will have acquired the target behavior and the reinforcement schedule may be thinned as appropriate.

This teaching strategy can only be further developed through more experiments. An important issue is the time at which it is beneficial to change from a non-differential to a differential reinforcement schedule. Overexposure to a non-differential reinforcement schedule may lead to prompt dependency, so it may be beneficial to switch to a differential reinforcement schedule early on in the program. On the other hand, withdrawing the non-differential reinforcement schedule too soon may result in the resurgence of problem behaviors. The best time to switch to a differential reinforcement schedule may be when a high number of correct responses are already occurring. To

increase the likelihood of a high number of correct responses occurring under a non-differential reinforcement schedule, the target behavior may have to be carefully chosen and a program of prompting and fading may be crucial as well.

The behavioral histories that lead to problem behaviors in demand situations can be studied further. Materials that have acquired aversive properties as a function of being correlated with aversive stimuli in the past may be likely to evoke problem behaviors when used in a discrete trial task. On the other hand, tasks that have been correlated with positive reinforcers and are preferred by the child may not evoke problem behaviors to the same degree. However, problem behaviors might develop as the task is presented repeatedly with a lot of errors and few reinforcers are delivered. A systematic investigation of the effects of using high preference versus low preference items in differential and non-differential reinforcement procedures could generate useful results.

Finally, non-differential and differential reinforcement might have different effects on problem behaviors, depending on the maintaining variables. For example, non-differential reinforcement may work well to decrease escape maintained behaviors, but automatically reinforced or attention maintained problem behaviors might not be affected in the same way. Those questions await further study.

Non-differential reinforcement is a procedure that appears to decrease the frequency of problem behaviors that occur following the presentation of demands. Teaching situations may thereby be made more pleasant and successful for both teacher and student. Applied behavior analysts may wish to apply this procedure in teaching situations in which many errors are likely to occur and prompting is needed. This may be

specifically beneficial in the behavioral treatment of autistic and other developmentally disabled children who have great difficulty learning. Along with other procedures that increase the density of reinforcement, non-differential reinforcement may ultimately help to make our teaching programs more successful.

APPENDIX

ILLUSTRATIONS

Figure 1: Cumulative occurrences of problem behaviors in experiment 1.

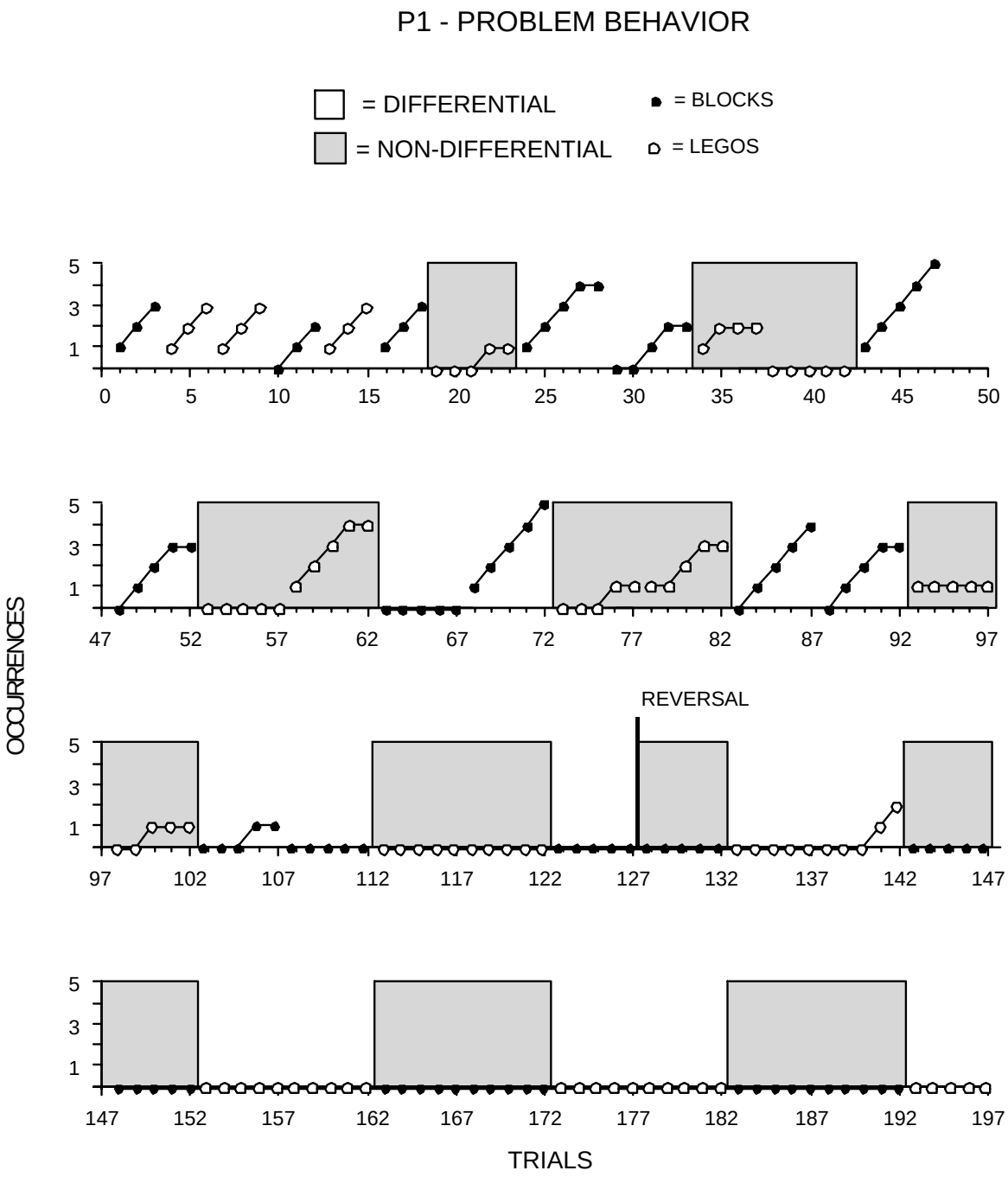

P1 - PROBLEM BEHAVIOR
= DIFFERENTIAL
= NON-DIFFERENTIAL
= BLOCKS
= LEGOS
OCCURRENCES
REVERSAL
TRIALS

Figure 2: Problem behaviors by session in experiment 1.

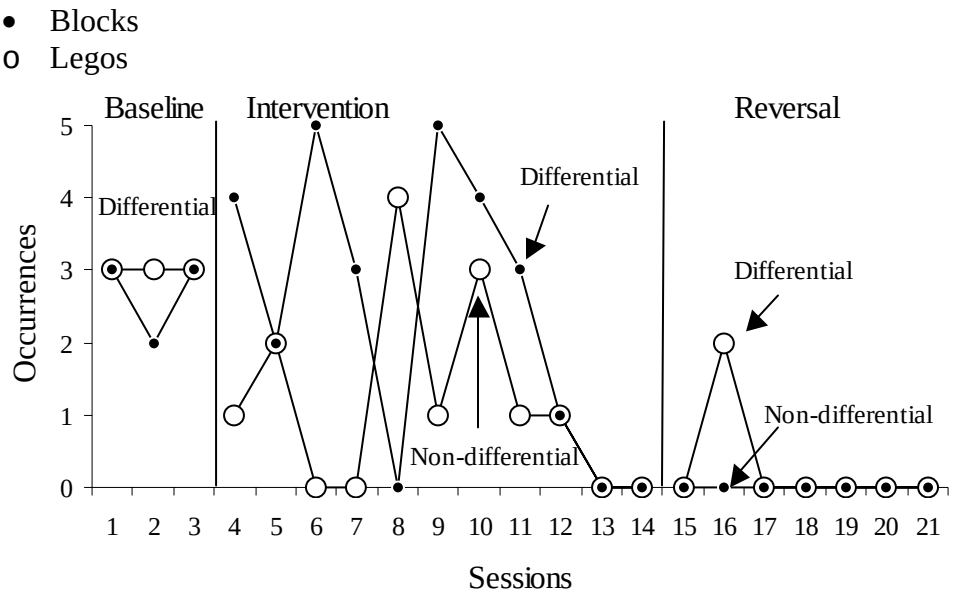

• Blocks
o Legos
Baseline
Intervention
Reversal
Differential
Differential
Differential
Non-differential
Non-differential
Occurrences
Sessions
0
1
2
3
4
5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Figure 3: Problem behaviors by condition in experiment 1.

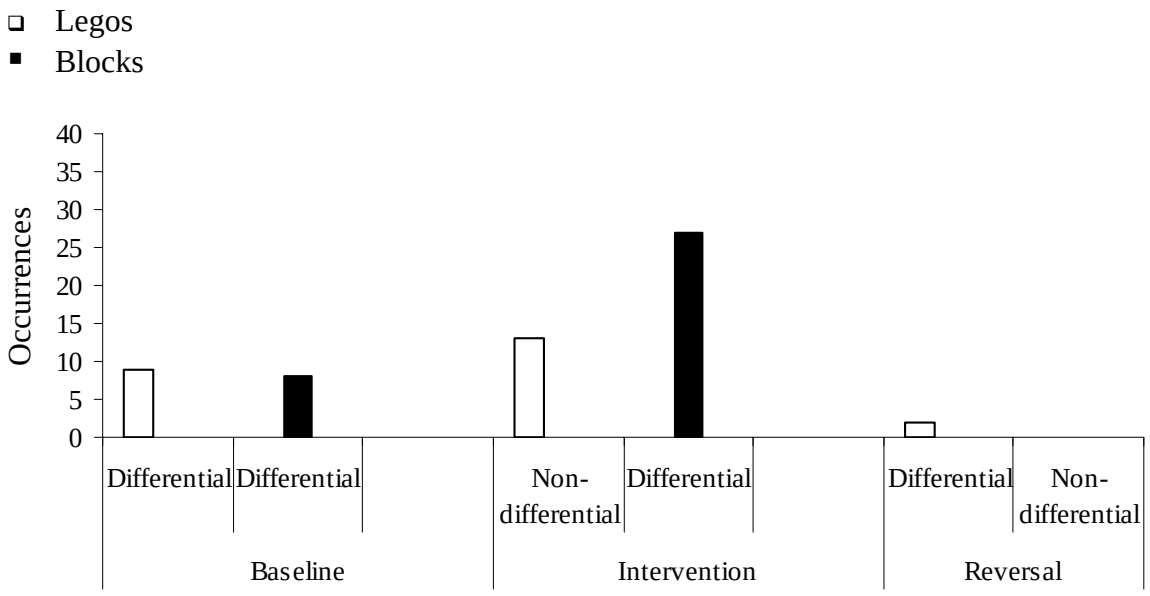

Legos
Blocks
Occurrences
40
35
30
25
20
15
10
5
0
Differential
Differential
Non-differential
Differential
Differential
Non-differential
Baseline
Intervention
Reversal

Figure 4: Cumulative occurrences of accurate responses in experiment 1.

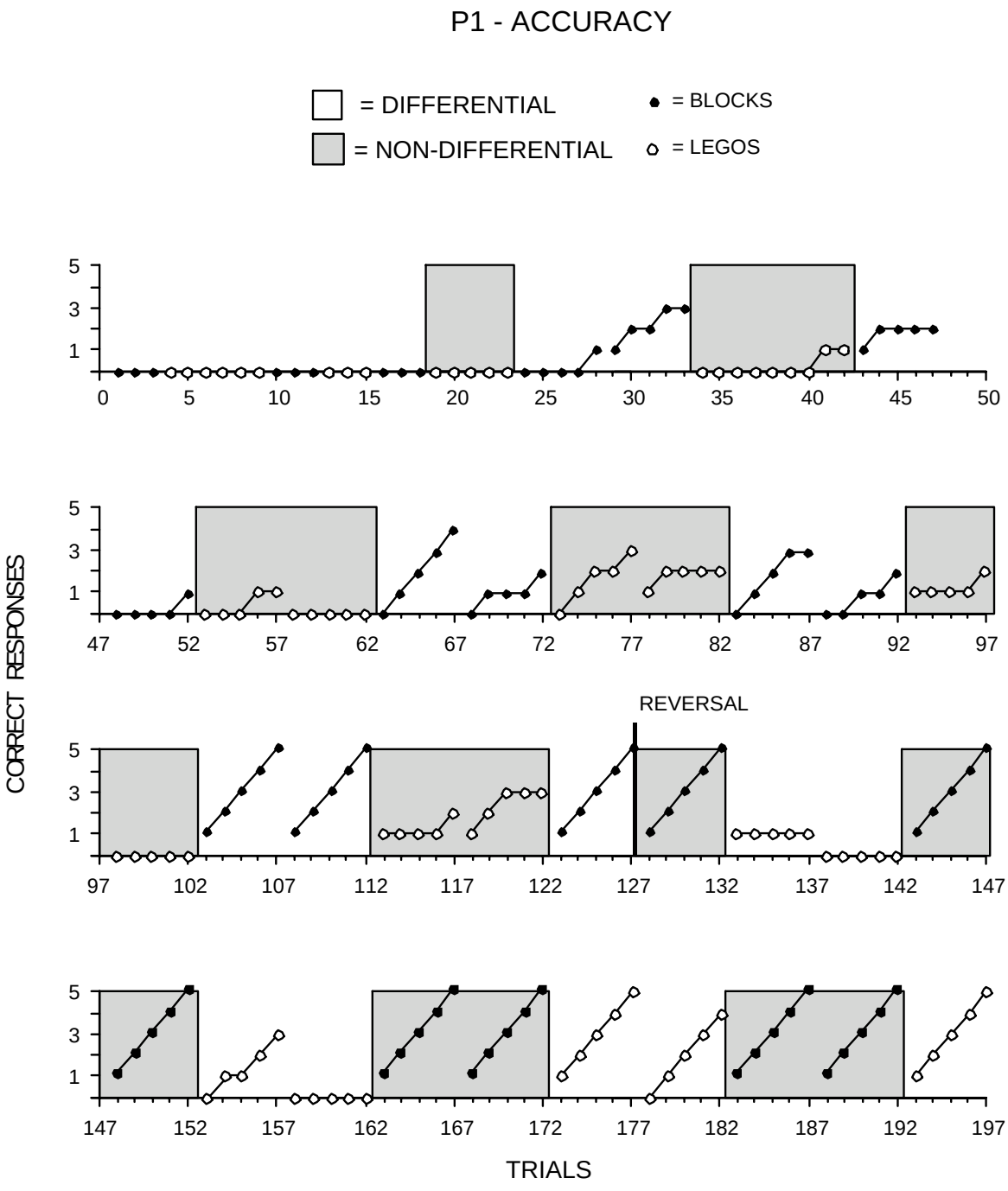

P1 - ACCURACY
= DIFFERENTIAL
= NON-DIFFERENTIAL
= BLOCKS
= LEGOS
CORRECT RESPONSES
REVERSAL
TRIALS

Figure 5: Session-by-session accuracy in experiment 1.

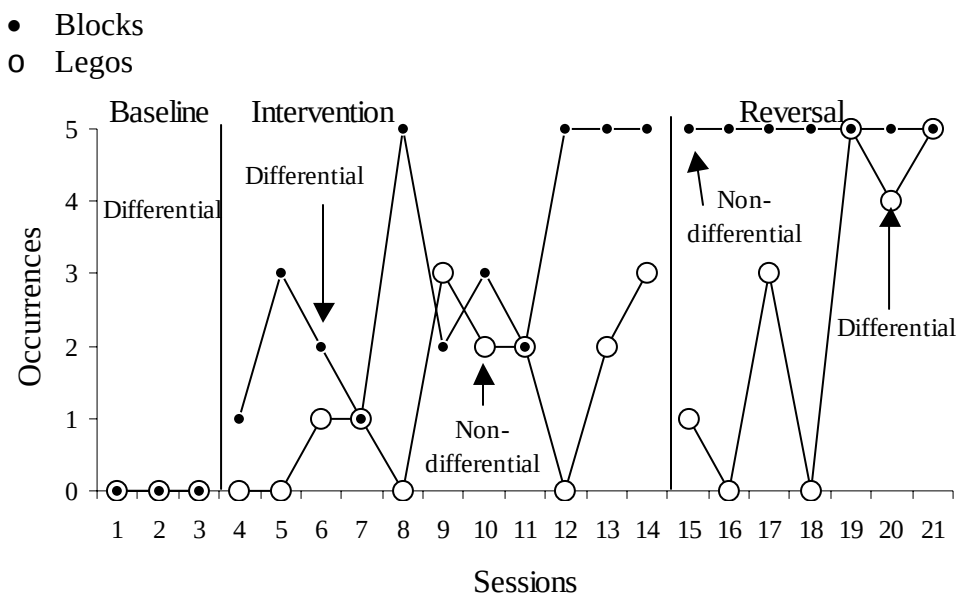

• Blocks
o Legos
Baseline
Intervention
Reversal
Differential
Differential
Non-differential
Non-differential
Differential
Occurrences
Sessions
0
1
2
3
4
5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Figure 6: Accuracy by condition for experiment 1.

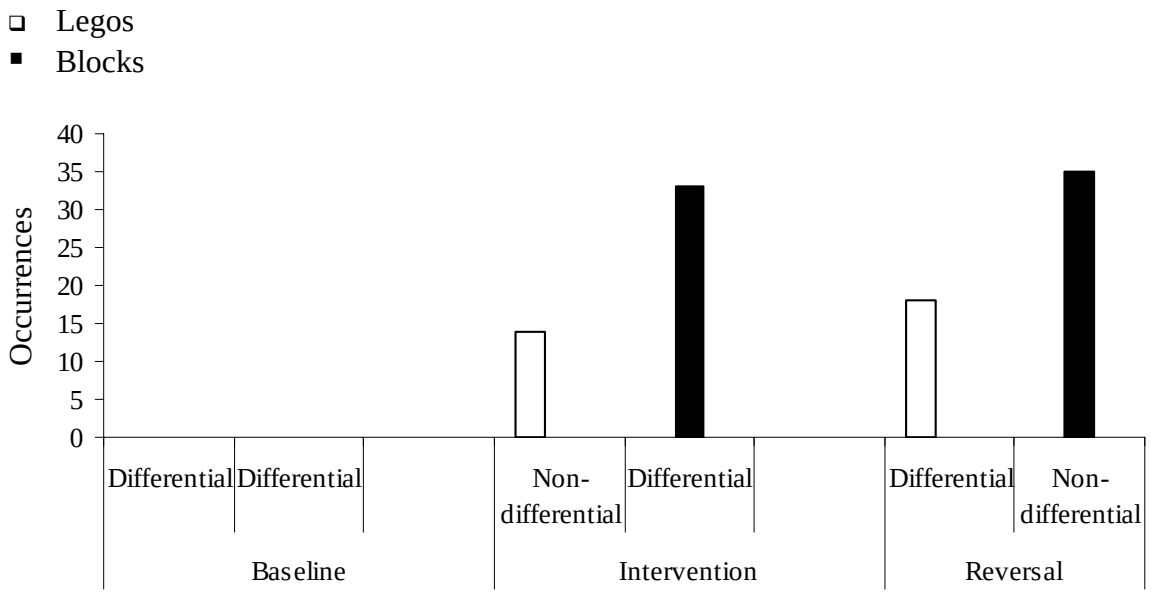

Legos
Blocks
Occurrences
40
35
30
25
20
15
10
5
0
Differential
Differential
Non-differential
Differential
Differential
Non-differential
Baseline
Intervention
Reversal

Figure 7: Cumulative occurrences of block throwing by participant 1 in experiment 2.

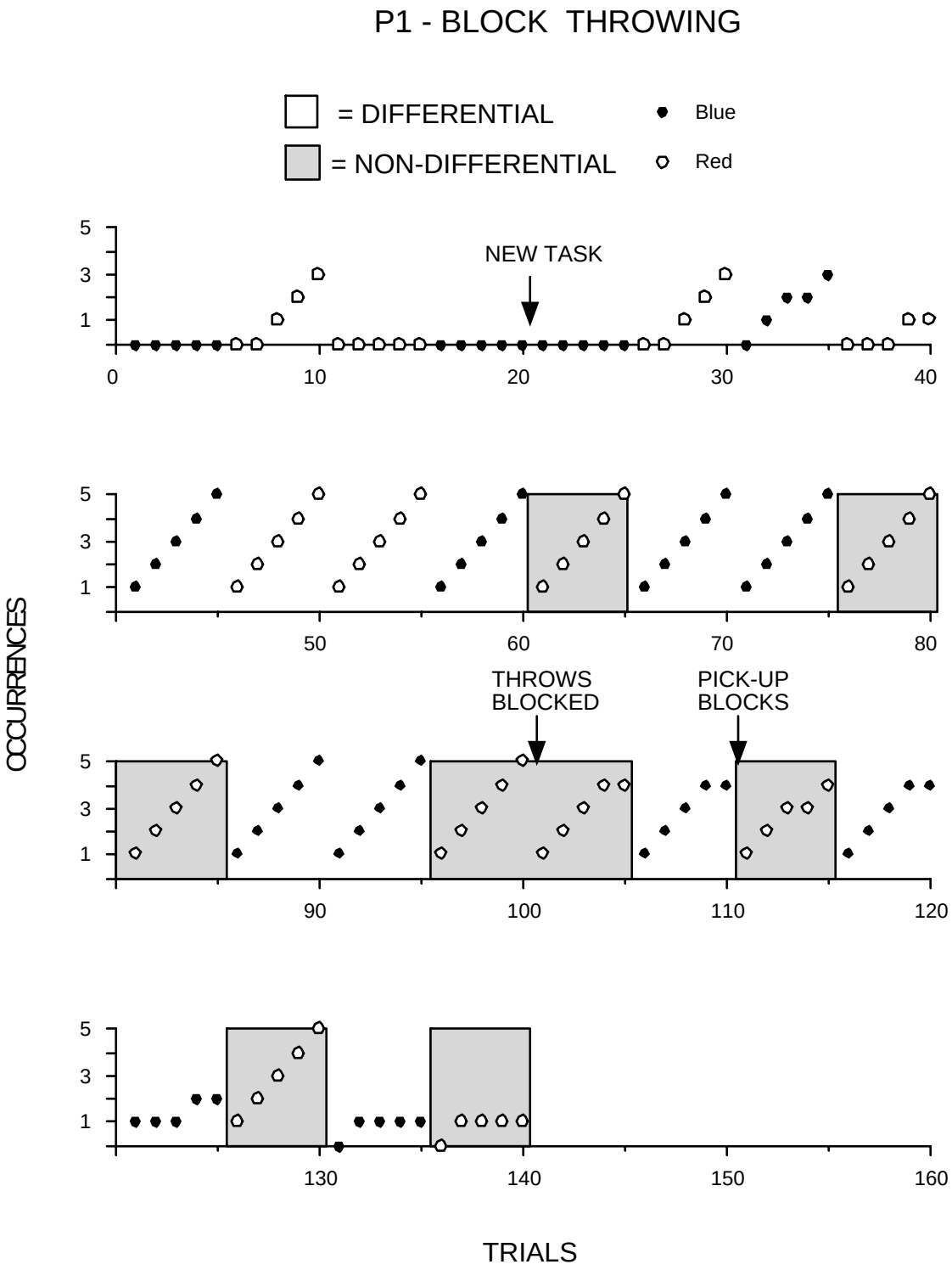

P1 - BLOCK THROWING
= DIFFERENTIAL
= NON-DIFFERENTIAL
Blue
Red
NEW TASK
THROWS BLOCKED
PICK-UP BLOCKS
OCCURRENCES
TRIALS
5
3
1
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

Figure 8: Cumulative occurrences of problem behaviors other than block throwing for participant 1 in experiment 2.

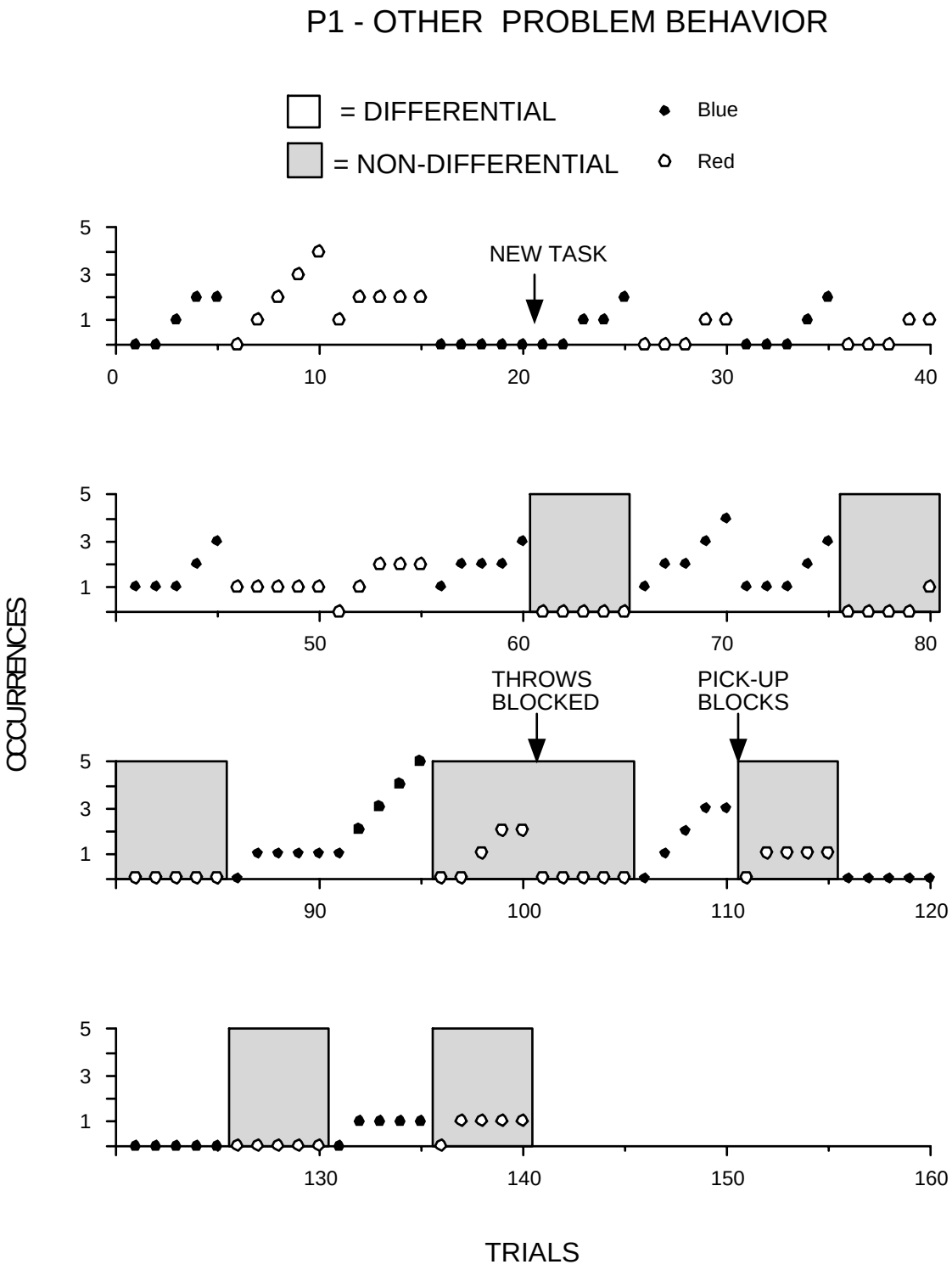

P1 - OTHER PROBLEM BEHAVIOR
= DIFFERENTIAL
= NON-DIFFERENTIAL
Blue
Red
NEW TASK
THROWS BLOCKED
PICK-UP BLOCKS
OCCURRENCES
TRIALS
5
3
1
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

Figure 9: Session-by-session occurrences of problem behaviors other than block-throwing for participant 1 in experiment 2.

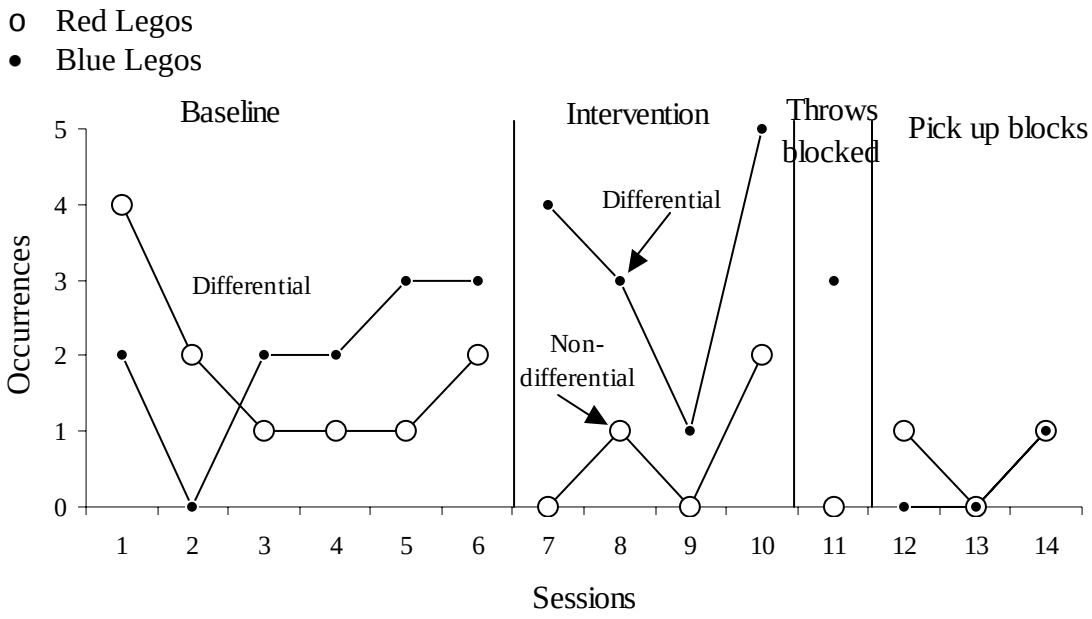

o Red Legos
• Blue Legos
Baseline
Intervention
Throws blocked
Pick up blocks
Differential
Differential
Non-differential
Occurrences
Sessions
0
1
2
3
4
5
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure 10: Problem behaviors other than block-throwing by condition, participant 1, experiment 2.

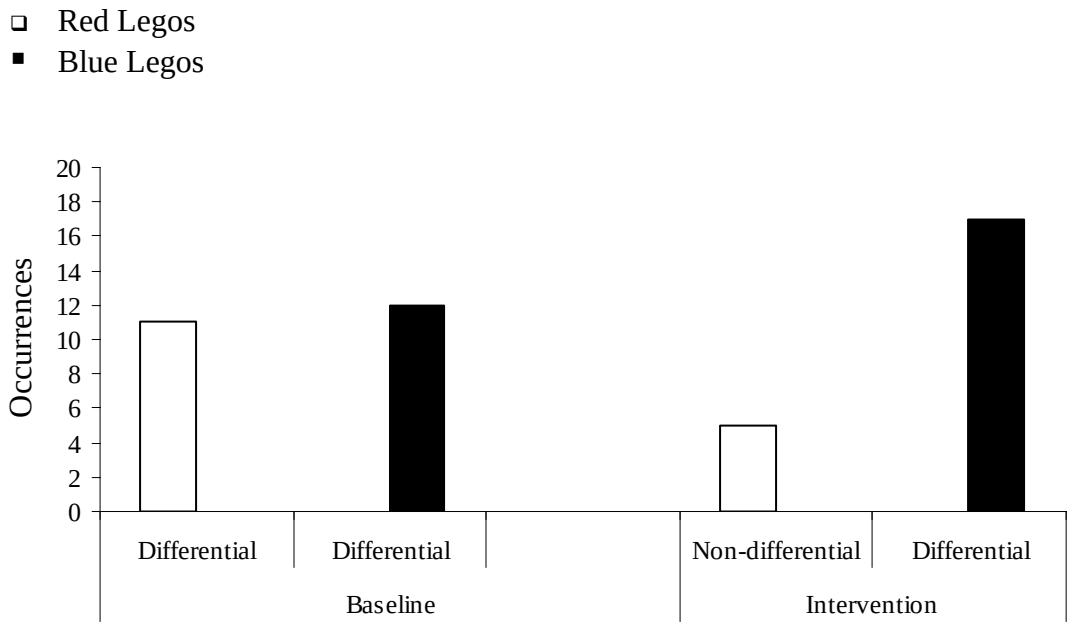

Red Legos
Blue Legos
Occurrences
20
18
16
14
12
10
8
6
4
2
0
Differential
Differential
Non-differential
Differential
Baseline
Intervention

Figure 11: Accuracy by session for participant 1, experiment 2.

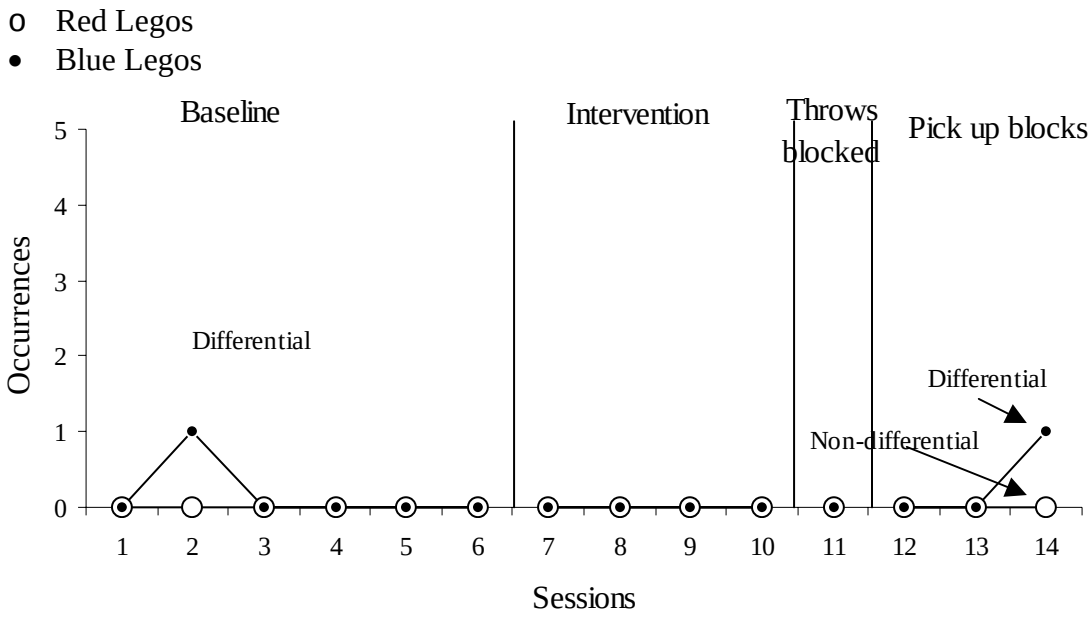

o Red Legos
• Blue Legos
Baseline
Intervention
Throws blocked
Pick up blocks
Occurrences
5
4
3
2
1
0
Differential
Differential
Non-differential
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Sessions

Figure 12: Cumulative occurrences of problem behaviors for participant 2, experiment 2.

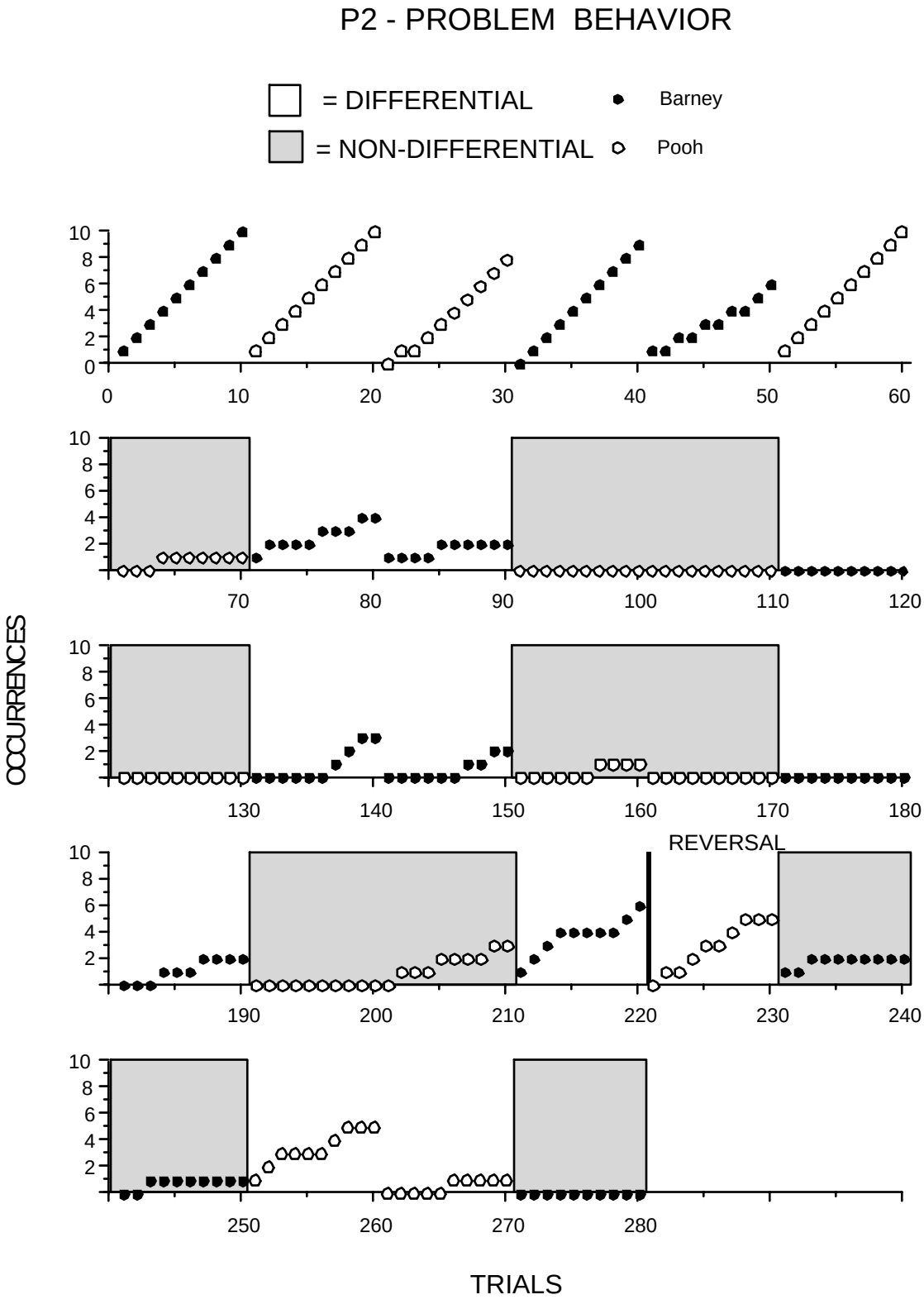

P2 - PROBLEM BEHAVIOR
= DIFFERENTIAL
= NON-DIFFERENTIAL
Barney
Pooh
OCCURRENCES
REVERSAL
TRIALS

Figure 13: Problem behaviors by session for participant 2, experiment 2.

o Winnie the Pooh

• Barney the dinosaur

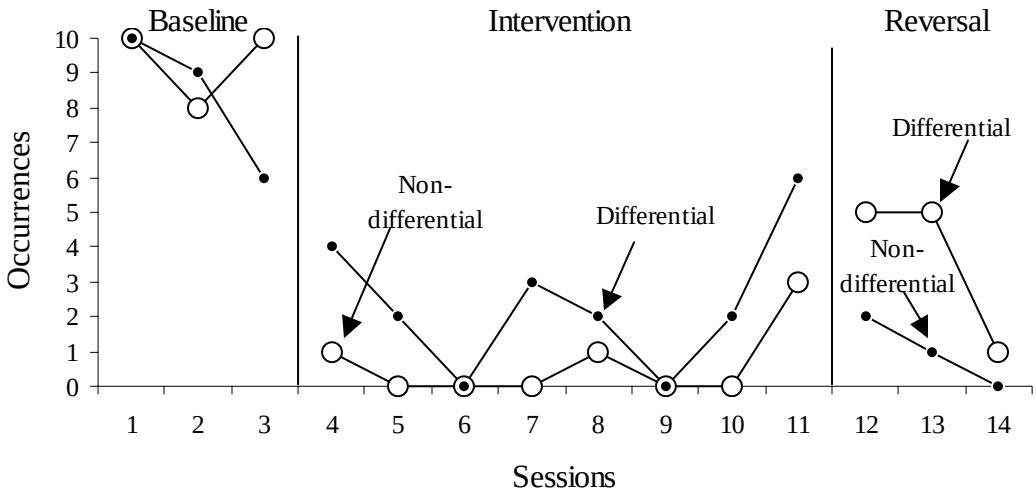


Figure 14: Problem behaviors by condition for participant 2, experiment 2.

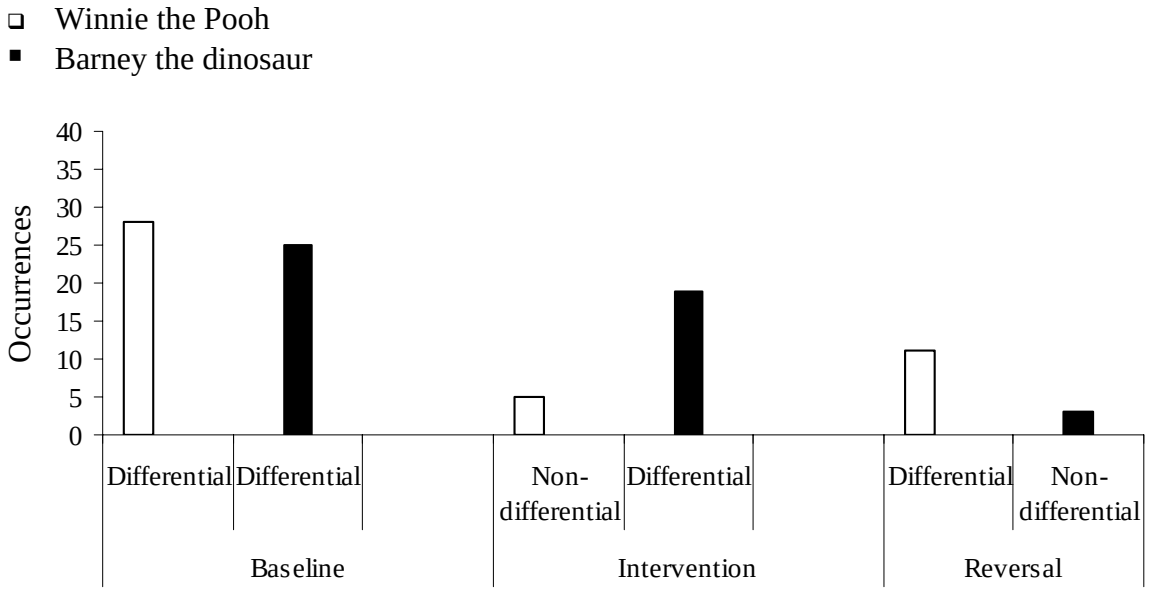

Winnie the Pooh
Barney the dinosaur
Occurrences
40
35
30
25
20
15
10
5
0
Differential
Differential
Non-differential
Differential
Differential
Non-differential
Baseline
Intervention
Reversal

Figure 15: Cumulative occurrences of accurate responses for participant 2, experiment 2.

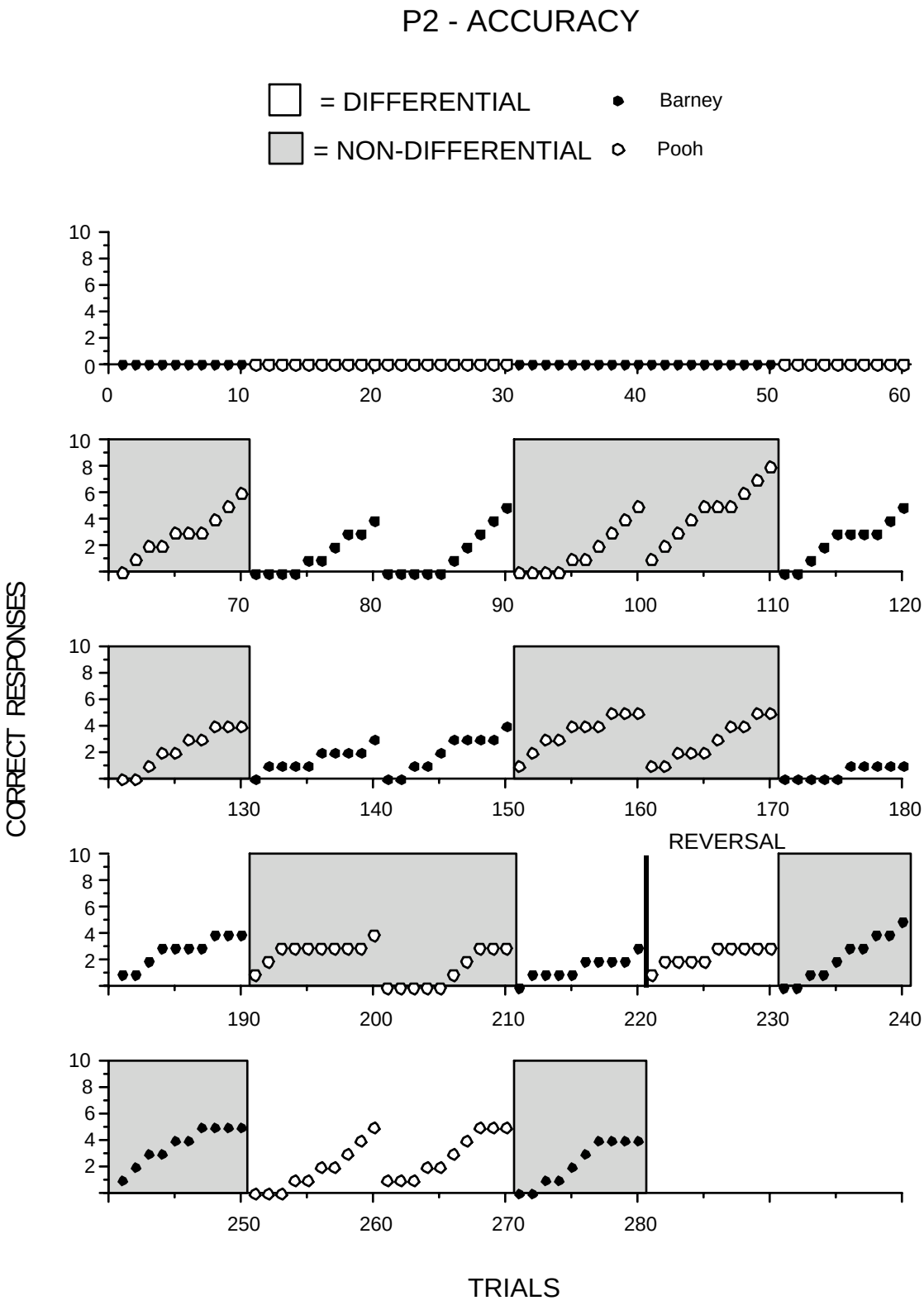

P2 - ACCURACY
= DIFFERENTIAL
= NON-DIFFERENTIAL
Barney
Pooh
CORRECT RESPONSES
REVERSAL
TRIALS

Figure 16: Accurate responses by session for participant 2, experiment 2.

o Winnie the Pooh

• Barney the dinosaur

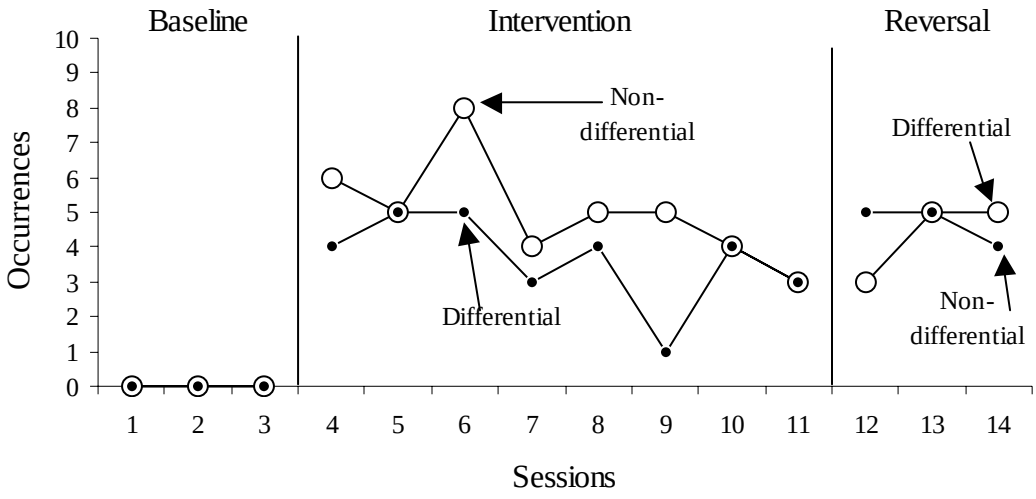
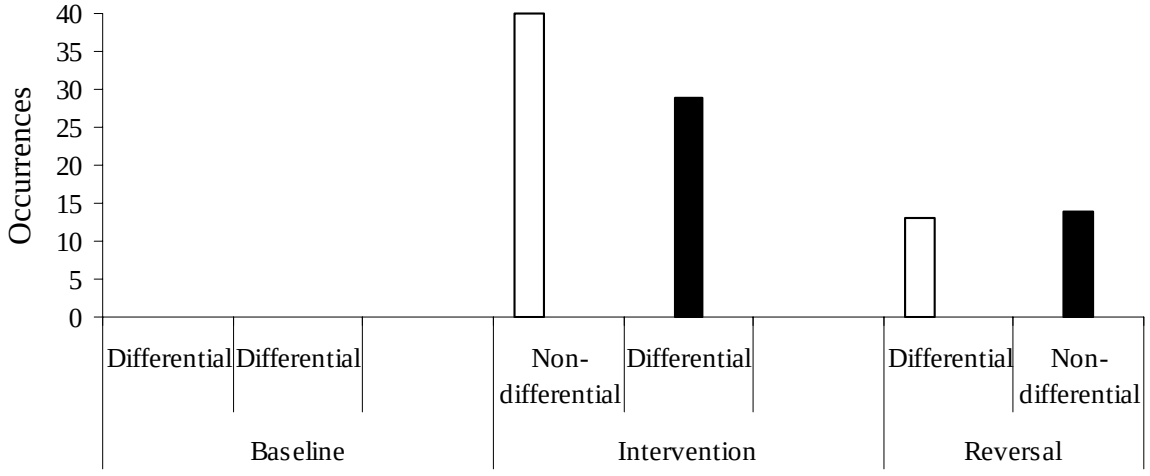


Figure 17: Accurate responses by experimental condition for participant 2, experiment 2.

- Winnie the Pooh
- Barney the dinosaur



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